

## CLAIMS

We claim:

1. A self-supporting reactive hot-melt adhesive element comprising:

a reactive one-component hot-melt adhesive which is solid at room-tempera-

5 ture, wherein said reactive one-component hot-melt adhesive comprises:

- (i) at least one isocyanate which is solid or liquid at room-temperature; and
- (ii) at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature.

2. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, especially wherein said least one isocyanate is embedded in said reactive polymer and/or resin matrix and/or wherein said least one isocyanate is homogeneously distributed over said least one reactive polymer and/or resin matrix.

3. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate is an aliphatic and/or aromatic di- and/or polyisocyanate, in particular with free terminal NCO-groups, especially wherein said isocyanate is selected preferably from the group consisting of: diisocyanatodiphenylmethanes (MDIs), in particular 4,4'-diisocyanatodiphenylmethane and 2,4'-diisocyanatodiphenylmethane and mixtures of various

diisocyanatodiphenylmethanes; 1,5-diisocyanatonaphthalene (NDI); diisocyanatotoluenes (TDIs), in particular 2,4-diisocyanatotoluene, as well as TDI-urethdiones, in particular dimeric 1-methyl-2,4-phenylene-diisocyanate (TDI-U), and TDI-carbamides; 1-isocyanato-3-isocyanatomethyl-3,5,5-trimethylcyclohexane (IPDI) and its isomers and derivatives, in particular di-, tri- and polymerisates, as well as IPDI-isocyanurate (IPDI-T); 3,3'-dimethylbiphenyl-4,4'-diisocyanate (TODI); 3,3'-diisocyanato-4,4'-dimethyl-N,N'-diphenylcarbamide (TDIH); as well as mixtures and prepolymers of the aforementioned compounds.

4. The reactive hot-melt adhesive element of claim 1, wherein the content of free NCO-groups in said reactive hot-melt adhesive element is at least 0.5 %w/w, in particular at least 1 %w/w, preferably at least 1.5 %w/w, especially preferred at least 2 %w/w, relative to the reactive hot-melt adhesive element.

5. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate is a mixture of 4,4'-diisocyanatodiphenylmethane and 2,4'-diisocyanatodiphenylmethane, preferably with a content of 2,4'-diisocyanatodiphenylmethane exceeding 20 %w/w, in particular exceeding 30 %w/w, preferably exceeding 40 %w/w, especially preferred exceeding 50 %w/w, relative to the isocyanate mixture.

6. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate has masking and/or blocking groups, said groups being able to split off in particular during exposure to heat and/or moisture.

7. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate is an encapsulated or surface-deactivated isocyanate, said encapsulation or surface-deactivation being preferably broken up at temperatures exceeding room-temperature.

8. The reactive hot-melt adhesive element of claim 1, wherein the least one isocyanate content is 0.5 to 30 %w/w relative to the reactive hot-melt adhesive element.

9. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate-reactive polymer and/or resin comprises at least two isocyanate-reactive groups or isocyanate-reactive hydrogen atoms per molecule, in particular hydroxyl, amino, carboxyl and/or carbonamide groups.

10. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate-reactive polymer and/or resin has an average molecular weight exceeding 8,000 g/mol, in particular of 10,000 to 50,000 g/mol, preferably 10,000 to 30,000 g/mol, and/or said least one isocyanate-reactive polymer and/or resin is preferably selected from the group consisting of isocyanate-reactive polymers and/or copolymers, especially isocyanate-reactive polyesters, polycaprolactone polyesters, polyethers, polyurethanes, polyamides, polytetrahydrofuranes, polyacrylates and polymethacrylates and their copolymers and mixtures.

11. The reactive hot-melt adhesive element of claim 1, wherein said least one isocyanate-reactive polymer and/or resin and said least one isocyanate are homogeneously distributed in each other.

12. The reactive hot-melt adhesive element of claim 1, wherein the content of said least one isocyanate-reactive polymer and/or resin is from 20 to 90 %w/w relative to the reactive hot-melt adhesive element.

13. The reactive hot-melt adhesive element of claim 1, further comprising at least one catalyst, preferably in amounts of from 0.01 to 5 %w/w relative to the reactive hot-melt adhesive element, said catalyst preferably being homogenously distributed over said least one isocyanate-reactive polymer and/or resin matrix and embedded herein, especially wherein said catalyst is a catalyst common or known from polyurethane chemistry, in particular selected from the group consisting of organic tin compounds such as dibutyl tin dilaurate (DBTL) or alkylmercaptide compounds of dibutyl tin; organic iron, lead, cobalt, bismuth, antimony and zinc compounds and mixtures of these compounds; and catalysts based on amines such as tertiary amines, 1,4-diazabicyclo-[2,2,2]-octane and dimorpholinodiethyl ether; as well as mixtures of these compounds.

14. The reactive hot-melt adhesive element of claim 1, further comprising at least one non-isocyanate-reactive polymer, wax and/or resin, which is preferably homogeneously distributed over said least one isocyanate-reactive polymer and/or resin matrix, preferably in amounts of from 0 to 60 %w/w relative to the reactive hot-melt adhesive element, especially wherein said non-isocyanate-reactive polymer, wax and/or resin is preferably selected from the group consisting of:

(i) aliphatic, cyclic or cycloaliphatic hydrocarbon resins, terpene phenol resins, cumarone indene resins,  $\alpha$ -methylstyrene resins, polymerized liquid resin esters or

ketonaldehyde resins, in particular resins with low acid values preferably of less than 1 mg KOH/g;

(ii) ethylene/vinyl acetate polymers or copolymers, in particular those with vinyl acetate contents of between 12 and 40 %w/w, in particular 18 to 28 %w/w, and/or with melt indices (MFIs, DIN 53735) of 8 to 800, in particular 150 to 500;

(iii) polyolefins, in particular with average molecular weights of 5,000 to 25,000 g/mol, preferably 10,000 to 20,000 g/mol, and/or with ring and ball softening ranges of between 80 and 170 °C, preferably between 80 and 130 °C;

(iv) (meth)acrylates such as styrene(meth)acrylates; and

(v) polyolefin waxes, in particular polyethylene and polypropylene waxes, and modified waxes on this basis;

and mixtures of these compounds.

15. The reactive hot-melt adhesive element of claim 14, wherein said least one non-isocyanate-reactive polymer, wax and/or resin combines with said least one isocyanate-reactive polymer and/or resin to form a matrix into which said least one isocyanate and optionally said other constituents of the reactive hot-melt adhesive element are incorporated, preferably in a homogeneous distribution.

16. The reactive hot-melt adhesive element of claim 1, further comprising at least one isocyanate-reactive mono-functional additive, preferably in an amount of from 0 to 20 %w/w relative to the reactive hot-melt adhesive element, said least one mono-functional

additive being preferably selected from the group consisting of mono-functional amines, alcohols, mercaptans and other mono-functional additives which comprise an isocyanate-reactive functional group.

17. The reactive hot-melt adhesive element of claim 1, wherein the individual constituents or contents are embedded and homogeneously distributed in each other.

18. The reactive hot-melt adhesive element of claim 1, wherein said adhesive element is non-sticky or non-adhesive at room-temperature and becomes sticky or adhesive at temperatures above room-temperature, in particular at temperatures of from 60 °C to 160 °C, and begins to cross-link above room-temperature, in particular at a temperature of from 60 °C to 160 °C, wherein the duration of cross-linking is less than 10 minutes, in particular less than 5 minutes, at temperatures of from 100 °C to 160 °C, in particular in the case of a solid isocyanate.

19. The reactive hot-melt adhesive element of claim 18, wherein when the cross-linking process has been initiated via heating to a temperature above room-temperature, in particular 100 °C to 160 °C, followed by immediate cooling to room-temperature, the duration of cross-linking is for about 5 to 8 days at room-temperature, in particular in the case of a solid isocyanate.

20. The reactive hot-melt adhesive element of claim 1, wherein said adhesive element cross-links during exposure to heat and/or moisture.

21. The reactive hot-melt adhesive element of claim 1, having a layer thickness of 10  $\mu\text{m}$  to 1,000  $\mu\text{m}$ , in particular 50  $\mu\text{m}$  to 500  $\mu\text{m}$ , preferably 100  $\mu\text{m}$  to 300  $\mu\text{m}$ .

22. The reactive hot-melt adhesive element of claim 1, in the form of a foil, film, strip or reactive adhesive tape, which may optionally be wound into a roll and/or stored in a cassette.

23. A reactive hot-melt adhesive element comprising:

from 0.5 to 30 % w/w. of at least one isocyanate;

from 20 to 90 %w/w of at least one isocyanate-reactive polymer and/or resin;

from 0 to 20 %w/w of at least one isocyanate-reactive, mono-functional

additive;

from 0 to 60 %w/w of at least one non-isocyanate-reactive polymer, wax and/or

resin; and

optionally, up to 5 %w/w, in particular in amounts of from 0.01 to 5 %w/w of a

catalyst; and

optionally, up to 25 %w/w, in particular in amounts of from 1 to 25 %w/w,

preferably 5 to 20 %w/w of at least one additive for improving heat conductivity and/or

sensitivity to radiation induction;

all amounts being based on the reactive hot-melt adhesive element.

24. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape, which comprises:

a reactive one-component hot-melt adhesive which is solid at room-tempera-

ture, said reactive one-component hot-melt adhesive comprising:

(i) about 0.5 to about 30 %w/w, based on said reactive hot-melt adhesive element, of at least one aliphatic or aromatic di- or polyisocyanate which is solid or liquid at room-temperature; and

(ii) about 20 to about 90 %w/w, based on said reactive hot-melt adhesive element, of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature and has an average molecular weight of at least 8,000 g/mol, said isocyanate-reactive polymer and/or resin comprising at least two isocyanate-reactive groups or functions per molecule;

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said di- or polyisocyanate is embedded in a homogeneous distribution, and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, relative to the reactive hot-melt adhesive element.

25. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape, which comprises a reactive one-component hot-melt adhesive which is solid at room-temperature,

said reactive one-component hot-melt adhesive comprising:

(i) about 0.5 to about 30 %w/w, based on said reactive hot-melt adhesive element, of a mixture of at least two aliphatic and/or aromatic di- and/or polyisocyanates which are solid or liquid at room-temperature, wherein at least one of said di- and/or



polyisocyanates is an unsymmetrically substituted di- and/or polyisocyanate comprising isocyanate functions of different reactivity; and

(ii) about 20 to about 90 %w/w, based on said reactive hot-melt adhesive element, of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature and has an average molecular weight of at least 8,000 g/mol, said isocyanate-reactive polymer and/or resin comprising at least two isocyanate-reactive groups or functions per molecule;

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said isocyanate mixture is embedded in a homogeneous distribution, and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, relative to the reactive hot-melt adhesive element.

26. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape, which comprises:

a reactive one-component hot-melt adhesive which is solid at room-temperature, said reactive one-component hot-melt adhesive comprising:

(i) about 0.5 to about 30 %w/w, based on said reactive hot-melt adhesive element, of a mixture of 4,4'-diisocyanatodiphenylmethane and 2,4'-diisocyanatodiphenylmethane, preferably with a content of 2,4'-diisocyanatodiphenylmethane exceeding 20 %w/w relative to said mixture; and

(ii) about 20 to about 90 %w/w, based on said reactive hot-melt adhesive element, of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature and has an average molecular weight of at least 8,000 g/mol, said isocyanate-reactive polymer and/or resin comprising at least two isocyanate-reactive groups or functions per molecule;

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-temperature, into which said isocyanate mixture is embedded in a homogeneous distribution, and wherein the content of free NCO-groups in the reactive hot-melt adhesive element is at least about 0.5 %w/w, relative to the reactive hot-melt adhesive element.

27. A self-supporting reactive hot-melt adhesive element, especially in the form of a foil, film, strip or reactive adhesive tape and having a layer thickness in the range of from about 10  $\mu\text{m}$  to about 1,000  $\mu\text{m}$ , said self-supporting reactive hot-melt adhesive element comprising:

a reactive one-component hot-melt adhesive which is solid at room-temperature which comprises:

about 0.5 to about 30 %w/w of at least one isocyanate which is solid or liquid at room-temperature;

about 20 to about 90 %w/w of at least one isocyanate-reactive polymer and/or resin which is solid at room-temperature;

optionally, up to about 20 %w/w of at least one mono-functional additive;

optionally, up to about 60 %w/w of at least one non-isocyanate-reactive  
polymer, wax and/or resin;

optionally, up to about 5 %w/w of at least one catalyst;

optionally, up to about 25 %w/w of at least one additive for improving heat  
5 conductivity and/or sensitivity to radiation induction;

all amounts being based on said reactive hot-melt adhesive element,

wherein said isocyanate-reactive polymer and/or resin forms a solid matrix at room-  
temperature, into which said isocyanate is embedded in a homogeneous distribution and wherein  
the content of free NCO-groups in the reactive hot-melt adhesive element is at least about  
10 0.5 %w/w, in particular at least about 1 %w/w, preferably at least about 1.5 %w/w, especially  
preferably at least about 2 %w/w, relative to the reactive hot-melt adhesive element.

28. A process for manufacturing the reactive hot-melt adhesive element of claim 1,  
said process comprising:

- a) mixing the individual constituents or contents, in particular while mildly  
15 heating, but without a reaction between the individual constituents or  
contents taking place in the case of a solid isocyanate;
- b) optionally, cooling or permitting to cool the resulting mixture or mass until  
said mixture or mass cools and/or hardens;
- c) processing the mixture or mass to a film, optionally with heating to above  
20 room-temperature, but without a reaction between the individual constituents  
or contents taking place;

- d) optionally, cooling or permitting the film to cool to room-temperature; and
- e) optionally, further processing the film, in particular dimensioning (such as into foils, smaller pieces etc.) and/or winding into rolls.

29. An adhesive bonding process for the permanent bonding of substrates to

5 be joined, comprising:

- a) providing a first and a second substrate to be bonded;
- b) applying the reactive hot-melt adhesive element of claim 1 to at least a region of the first substrate, in particular during exposure to heat and/or pressure, if necessary while melting the reactive constituents and thereby initiating the cross-linking process;
- c) joining said first and second substrates while contacting said second substrate with at least the region of the first substrate provided with the reactive hot-melt adhesive element, preferably under pressure;
- d) pressing together said two substrates, if necessary while initiating the cross-linking process, in particular during exposure to heat and/or moisture; and then;
- e) hardening or curing, optionally during exposure to pressure and/or heat and/or moisture.

30. An adhesive bonding process for the permanent bonding of substrates to be

20 joined, comprising:

- a) providing a first and a second substrate to be bonded and the reactive hot-melt adhesive element according to claim 1;
- b) joining said first and second substrate with said reactive hot-melt adhesive element being positioned between said first and second substrates;
- c) pressing together said first and second substrates joined together in step b), in particular during exposure to heat and/or moisture, preferably while melting the reactive constituents and thereby initiating the cross-linking process; and then
- d) hardening or curing, optionally during exposure to pressure and/or heat and/or moisture.